25VT6A5VGEVB

25VT6A5VGEVB Evaluation Board User's Manual

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EVAL BOARD USER'S MANUAL

Description

The 25VT6A5VGEVB evaluation board is designed such that it can accommodate a 1x1 to a 2x2 combination of MOSFETs, for μ8−FL and SO8−FL packages. Depending on the type of application and necessity, any combination of the above packages can be used. The 25VT6A5VGEVB evaluation board is designed to operate with an input voltage ranging from 8 V to 16 V, and to provide an output voltage of 0.8 V to 1.8 V for load currents of up to 25 A. The 25VT6A5VGEVB comes with a 5 V driver. The 25VT6A5VGEVB evaluation board has a number of test points that can be used to evaluate its performance in any given application.

Features

- 8 V to 16 V Input Voltage
- 25 A of Steady State Load Current
- 500 kHz Switching Frequency
- Access to IC Features such as Enable, Switching Node and VID Settings for Output Voltage
- Convenient Test Points for Simple, Non−invasive Measurements of Converter Performance Including Input Ripple, Output Ripple, High Side and Low Side Gate Signals and Switching Node

Applications

- Synchronous Buck Converters
  - High Frequency Applications
  - High Current Applications
  - Low Duty Cycle Applications
- Multi−phase Synchronous Buck Converters
  - Evaluation Board has only One Phase Implemented

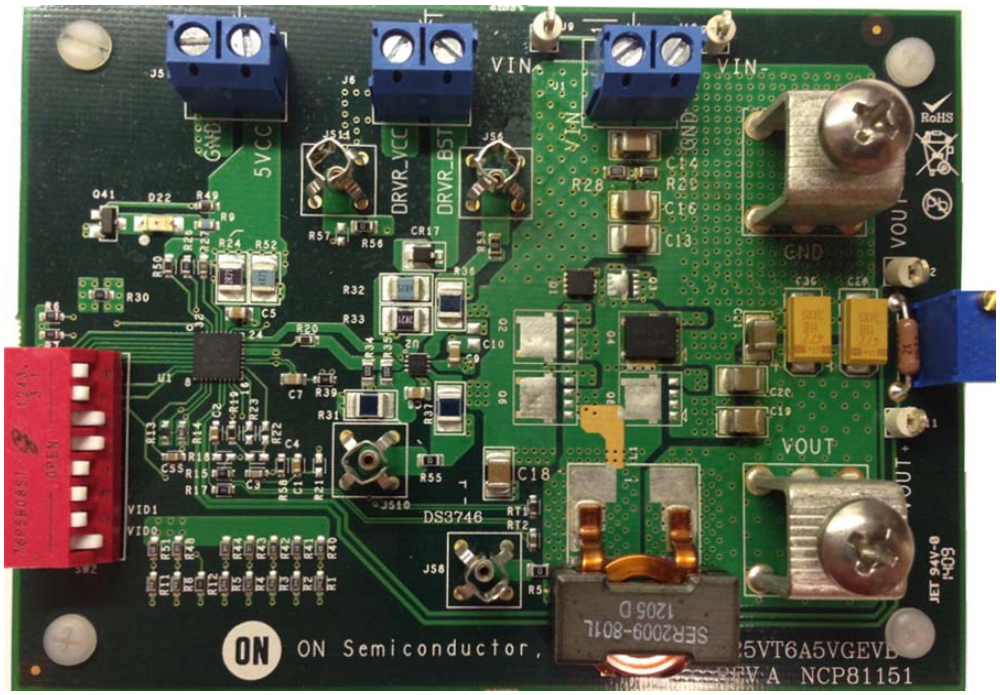

Figure 1. 25VT6A5VGEVB Evaluation Board

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EVALUATION BOARD SCHEMATIC

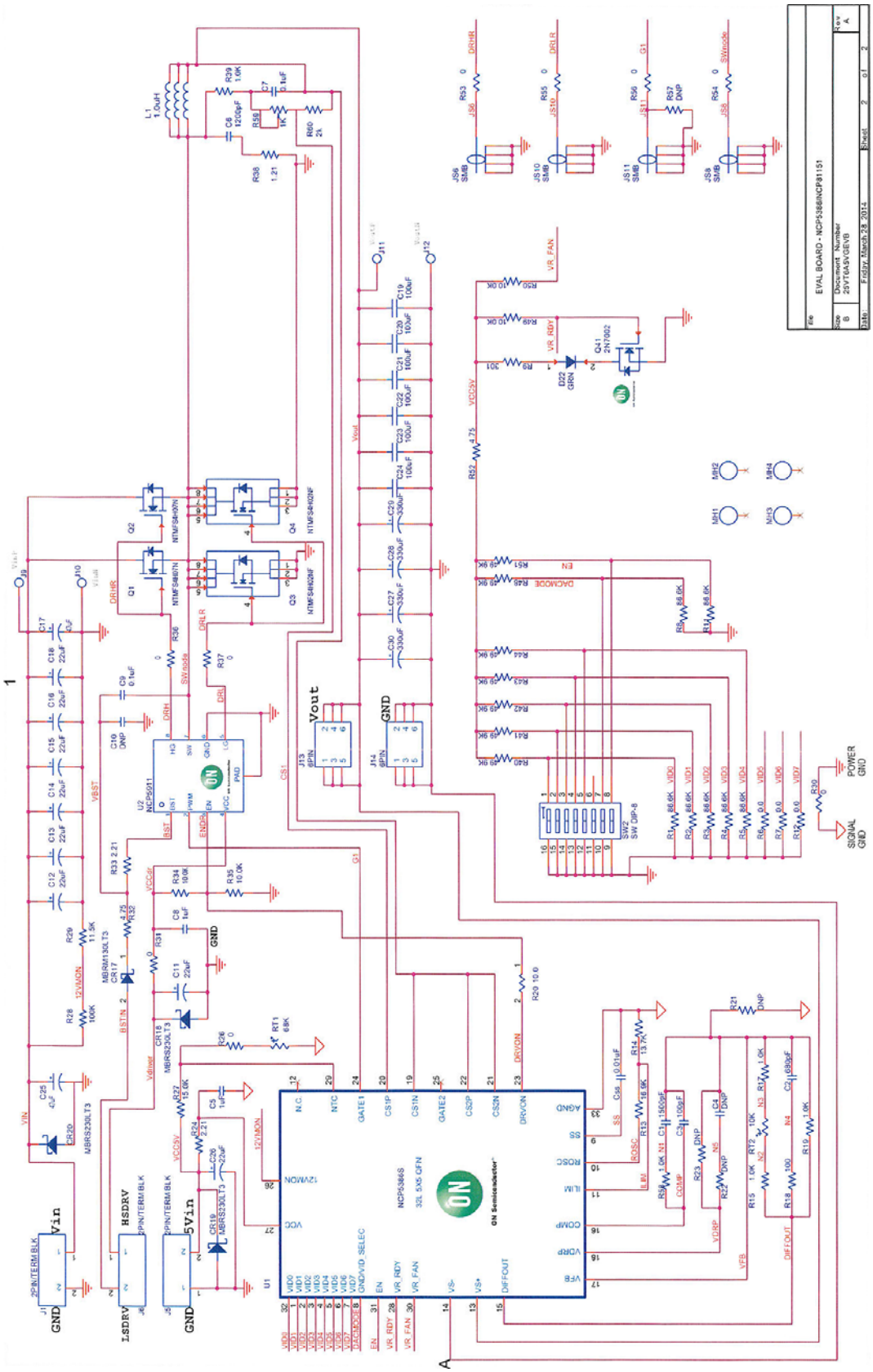

Figure 2. Schematic of the 25VT6A5VGEVB Evaluation Board

ELECTRICAL SPECIFICATIONS

Table 1. ELECTRICAL SPECIFICATIONS FOR 25VT6A5VGEVB

Parameter		Notes and Conditions	Min	Typ	Max	Units
Input Characteristics						
V_{in}	Input Voltage	–	8	12	16	V
V_{drvr}	Driver Voltage	–	4.5	5	6.5	V
V_{CC}	Controller Voltage	–	0	5	7	V
I_{in}	Input Current	V_{in} = 12 V; I_{out} = 25 A	0	–	3	A
	No load input current	V_{in} = 12 V; I_{out} = 0 A; V_{drvr} = 5 V	0	9	–	mA
Output Characteristics						
V_{out}	*Output Voltage	V_{in} = 12 V; I_{out} = 25 A	0.8	1.2	1.8	V
V_{p-p}	Maximum Switch Node Voltage	V_{in} = 12 V; I_{out} = 20 A; V_{drvr} = 5 V	–	16	–	V
I_{out}	Output Current	V_{in} = 8 V to 16 V	0	–	25	A
System Characteristics						
F_{SW}	Switching Frequency	Note 1	–	500	–	kHz
η_{Peak}	Peak Efficiency	V_{in} = 12 V; V_{out} = 1.2 V; V_{drvr} = 5 V	–	91	–	%
η	Full load efficiency	V_{in} = 12 V; V_{out} = 1.2 V; V_{drvr} = 5 V; I_{out} = 25 A	–	87	–	%

*The output voltage can be adjusted by changing the VID settings. See Appendix.
1. The switching frequency is defined by the resistors R13 and R14 and can only be changed only by changing the resistors R13 and R14.

CONNECTORS AND TEST POINTS DESCRIPTIONS

Input Power

Connect the input voltage positive probe to Pin 1 of J1 and sense probe at J9, negative probe to the GND at Pin 2 of J1 and sense probe at J10. The input voltage can range from 8 V to 16 V.

Output Power

Connect the output voltage positive probe to J13 (large screw connector) and sense probe at J11, ground probe at J14 (large screw connector) and the sense probe to J12. The output voltage is set by the VID settings (SW2) and the potentiometer (R60). Please refer to Start-Up Procedure and Appendix.

Controller Biasing

Connect the positive probe to Pin 2 of J5 and the negative probe to the GND at Pin 1 of J5. Please keep this as a separate supply to avoid damage to the controller, especially when other drive voltages are used.

Driver Biasing

The driver positive voltage probe V_{CC} should be connected to both pin 1 and 2 of J6. The driver voltage is defined in Table 1. The 25VT6A5VGEVB evaluation board is set up to accept DFN8 footprints of ON Semiconductor 5 V drivers.

Switching Frequency

The converter switching frequency is set by the voltage divider setup of R13 and R14 between the pins 10 (ROSC) and 33 (AGND) of the NCP5386 controller. In order to change the frequency, these resistors have to be changed. Changing the frequency also changes the I_{lim} (Over Current shutdown threshold) settings.

Table 2. R13, R14 1% RESISTOR VALUES FOR FREQUENCY SET

Frequency (kHz)	R13 (kΩ)	R14 (kΩ)
300	26.7	7.32
400	19.1	5.23
500	14.7	4.02
600	12.1	3.24
700	10.0	2.74

Test Points Description

Monitoring the Input Voltage

The input voltage can be monitored by using the test points at J9 and J10 on the 25VT6A5VGEVB evaluation board. This allows the user to find out the exact value of input voltage since there will be no losses from the cables or connectors.

Monitoring the Output Voltage

The 25VT6A5VGEVB evaluation board provides two test points for measuring the output voltage without any losses from the cables or connectors. The output voltage can be measured at the points J11 and J12 on the evaluation board.

Monitoring the Switch Node Waveforms

The 25VT6A5VGEVB evaluation board provides the opportunity to monitor the switch node waveforms. The probe socket at test point JS8 provides the switch node waveforms.

Monitoring the High Side and Low Side Waveforms

The high side waveforms can be obtained from the probe socket at test point JS6 and the low side waveforms can be obtained from the probe socket at test point JS10.

The probe sockets that are provided on the evaluation board for monitoring the waveforms are such that the oscilloscope probes can be inserted into the probe socket and are held in place. The Test Point and the Probe Socket are shown in Figure 3.

Monitoring the PWM Signal

The PWM signal from the controller to the driver can be monitored from the probe socket provided at JS11.

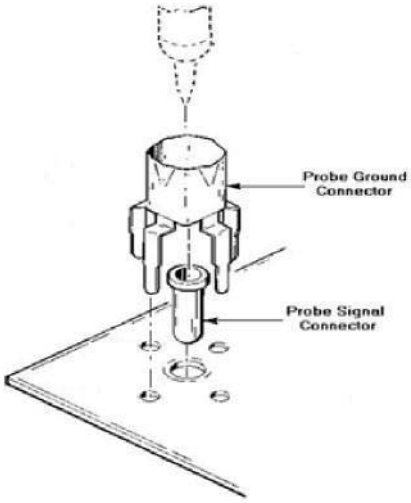

Figure 3. Tektronix Test Point & Probe Socket
Part #: 700503100

TEST EQUIPMENT REQUIRED

Voltage Sources

(i) DC Supply Source for Input Voltage

The input voltage source should be a 0 to 20 V DC source. The input voltage may be increased further depending on the parts that are being used on the 25VT6A5VGEVB evaluation board such that the part can withstand the applied voltage. Hence, based on the required input voltage to be applied, the requirement of the DC power supply varies.

(ii) DC Supply Source for Driver Voltage

The supply source for the driver should be a 0 to 10 V source. The driver voltage should never exceed 6.5 V.

Electronic Load

The electronic load supplied to the 25VT6A5VGEVB evaluation board ranges from 0 A to 25 A. Hence a DC current source of 0 A to 30 A is needed for the evaluation board.

Meters to Measure Voltages and Currents

In the 25VT6A5VGEVB Evaluation Board, the voltages that are to be measured are Vin, Vout and Vdrv. The set up for measuring these voltages are shown in Figure 4. The connecting wires from the output terminal to the electronic load should be thicker in order to avoid losses and to measure the exact voltage at the end of the terminals.

Oscilloscope

The oscilloscope is used to monitor the gate and switch node waveforms. This should be an analog or digital oscilloscope set for DC coupled measurement with 50 MHz bandwidth. The resolution can be set at 5 V/division vertically and 20ns/division horizontally. The oscilloscope channels can be connected at various test points such as high side gate (JS6), low side gate (JS10), switch node (JS8), the driver PWM Signal (JS11), Vin (sense) (J9 & J10) and Vout (sense) (J11 & J12).

TEST SET UP AND PROCEDURE

Test Setup

The test set up, test points and components present on the 25VT6A5VGEVB Evaluation Board are shown in Figure 4. The MOSFET parts placed on the evaluation board are the Q1 and Q4 (Refer to Figure 1).

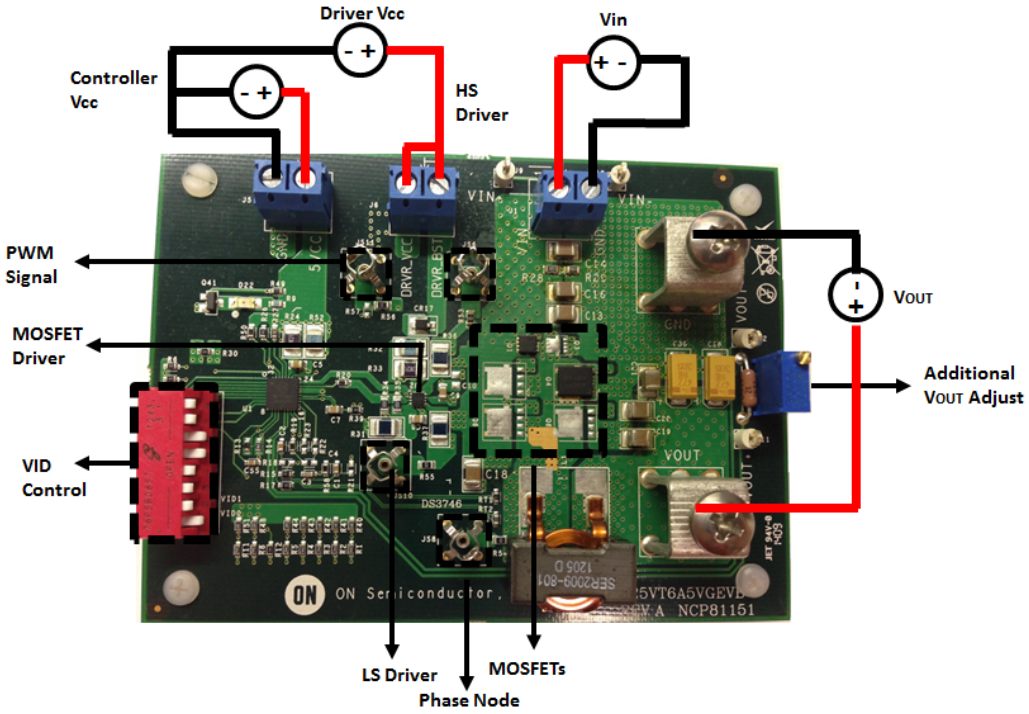

Figure 4. Schematic of the Test Setup

Start up and Shut down Procedures

Before starting the test, the oscilloscope probes should be connected. IR or k−type thermo−couples can be used to monitor the temperature of the parts. IR monitoring requires the removal of the oscilloscope probes due to the IR beam interference.

Start up Procedure (VOUT 0.8 V − 1.56 V):

1. Initially set all the power supplies to 0 V.
2. Set the output voltage to the desired value by changing the VID settings on SW2 (see Appendix). The SW2 must be changed while the driver and controller are off.
3. Set the driver voltage and controller voltage to 5 V.
4. Set the input voltage to the desired value (8 V − 16 V).
5. V_{OUT} Adjustments: the output voltage may be fine−tuned at this time, by adjusting the R60 potentiometer.
6. Set the load current to required value. The load current must be incremented slowly to prevent the controller from shutting down due to transient spikes on the inductor current sense lines (CS1, CS2 in Figure 2). If the controller shuts down, there are two different methods that can be used to reset the controller. The first method is to toggle Pin 8 (EN) of the Grayhill switch (SW2) to 0 (down position) and then back to 1 (up position). The second method is to set VIN to 0 V and then back up to the desired voltage, then turned on and Vin re−established.

Start up Procedure (VOUT 1.56 V − 1.8 V):

1. Initially set all the power supplies to 0 V.
2. Set the output voltage to 1.56 V by changing the VID settings on SW2 (see Appendix). The SW2 must be changed while the driver and controller are off.
3. Set the driver voltage and controller voltage to 5 V.
4. Set the input voltage to the desired value (8 V − 16 V).
5. Adjust the output voltage using the R60 potentiometer until the desired output voltage is reached (1.8 V maximum).
6. Set the load current to required value. The load current must be incremented slowly to prevent the controller from shutting down due to transient spikes on the inductor current sense lines (CS1, CS2 in Figure 2). If the controller shuts down, there are two different methods that can be used to

reset the controller. The first method is to toggle Pin 8 (EN) of the Grayhill switch (SW2) to 0 (down position) and then back to 1 (up position). The second method is to set VIN to 0 V and then back up to the desired voltage, then turned on and Vin re−established.

Shut down Procedure (VOUT 0.8 V − 1.56 V):

1. Shut down the load.
2. Reduce the input voltage to zero and then shut down the input power supply.
3. Reduce the driver voltage and controller voltage to zero. Then shut down the driver power supply and controller power supply.

Shut down Procedure (VOUT 1.56 V − 1.8 V):

1. Shut down the load.
2. Adjust the potentiometer until the output voltage measures 1.56 V.
3. Reduce the input voltage to zero and then shut down the input power supply.
4. Reduce the driver voltage and controller voltage to zero. Then shut down the driver power supply and controller power supply.

Test Procedure

1. Before making any connections, make sure to set all power supplies to 0 V, and make sure the load current is 0 A.
2. Connect the oscilloscope probes at the desired test points.
3. Connect the voltmeters/multi−meters to monitor the required parameters. (Refer to Figure 4).
4. Set the output voltage to 1.2 V and the input voltage to 12 V, following the Start−Up Procedure specified in the previous section.
5. Obtain the required data and waveforms.
6. Follow the Shut−Down Procedure specified in the previous section.

TEST RESULTS

The following test results were obtained for the 25VT6A5VGEVB evaluation board by following the Test Procedure listed above. The selected MOSFETs were evaluated in a 1 x 1 combination.

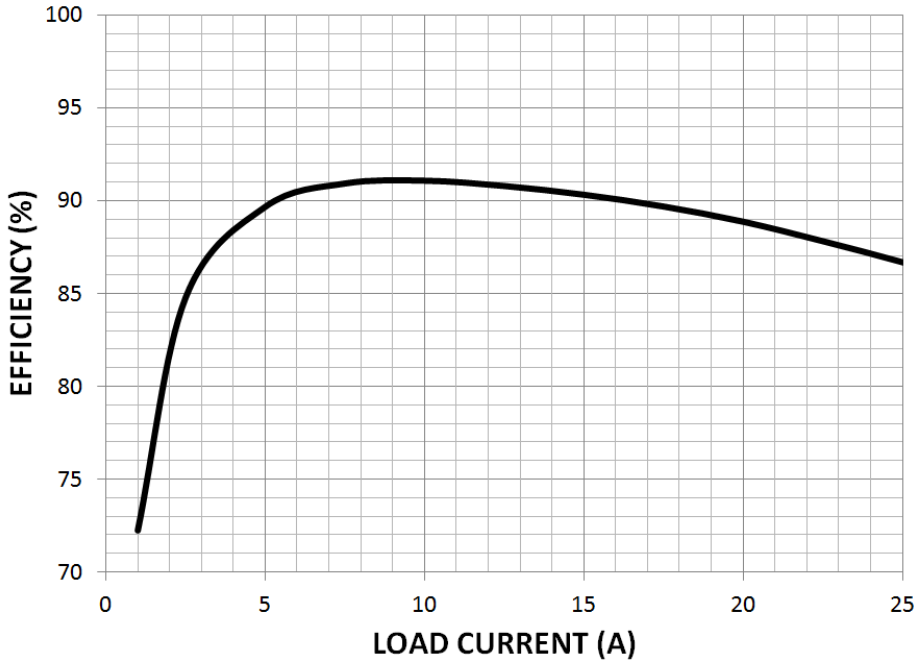

Figure 5. Efficiency of NTTFS4H07N x NTMFS4H02NF for V_{IN} = 12 V, V_{OUT} = 1.2 V, V_{DRV} = 5 V, F_{SW} = 500 kHz

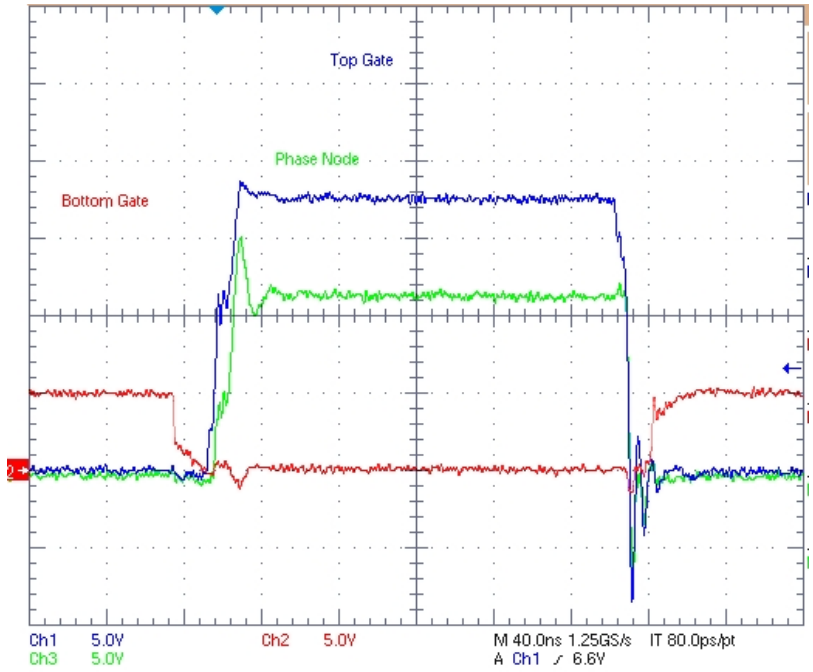

Figure 6. Switch Node and Gate Waveforms of NTTFS4H07N x NTMFS4H02NF taken at I_{OUT} = 20 A

APPENDIX

Table of AMD VID Settings for NCP5386B Controller

The Grayhill 76PSB08ST 8 position switch used for setting the output voltage of the synchronous buck converter. Figure 7 below shows the pin assignment of the switch. VID0 – VID5 set the output voltage. DAC, and EN is the enable pin of the controller (controller reset). EN must always be in the up position (1) unless a reset is performed. To set the output voltage to 1.2 V, for example: VID0 = 0 (down), VID1, VID2, VID3 = 1 (up), VID4 = 0 (down), and VID5, DAC, EN = 1 (up).

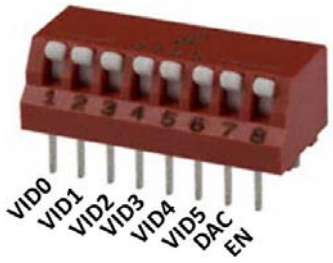

Figure 7. Grayhill Switch Pin Labeling

Table 3. VID CONTROL SETTINGS FOR OUTPUT VOLTAGE

PIN 1	PIN 2	PIN 3	PIN 4	PIN 5	PIN 6	PIN 7	PIN 8		
VID0	VID1	VID2	VID3	VID4	VID5	DAC	EN	V_{OUT} (V)	Tolerance
0	0	0	0	0	1	1	1	1.5625	±0.5%
1	0	0	0	0	1	1	1	1.5375	±0.5%
0	1	0	0	0	1	1	1	1.5125	±0.5%
1	1	0	0	0	1	1	1	1.4875	±0.5%
0	0	1	0	0	1	1	1	1.4925	±0.5%
1	0	1	0	0	1	1	1	1.4400	±0.5%
0	1	1	0	0	1	1	1	1.4125	±0.5%
1	1	1	0	0	1	1	1	1.3875	±0.5%
0	0	0	1	0	1	1	1	1.3625	±0.5%
1	0	0	1	0	1	1	1	1.3375	±0.5%
0	1	0	1	0	1	1	1	1.3125	±0.5%
1	1	0	1	0	1	1	1	1.2875	±0.5%
0	0	1	1	0	1	1	1	1.265	±0.5%
1	0	1	1	0	1	1	1	1.2400	±0.5%
0	1	1	1	0	1	1	1	1.2125	±0.5%
1	1	1	1	0	1	1	1	1.1900	±0.5%
0	0	0	0	1	1	1	1	1.1625	±0.5%
1	0	0	0	1	1	1	1	1.1375	±0.5%
0	1	0	0	1	1	1	1	1.1125	±0.5%
1	1	0	0	1	1	1	1	1.0900	±0.5%
0	0	1	0	1	1	1	1	1.0650	±0.5%
1	0	1	0	1	1	1	1	1.0400	±0.5%
0	1	1	0	1	1	1	1	1.0125	±0.5%
1	1	1	0	1	1	1	1	0.9875	±0.5%
0	0	0	1	1	1	1	1	0.9625	±0.5%
1	0	0	1	1	1	1	1	0.9375	±0.5%
0	1	0	1	1	1	1	1	0.9125	±0.5%
1	1	0	1	1	1	1	1	0.8900	±0.5%
0	0	1	1	1	1	1	1	0.8650	±0.5%
1	0	1	1	1	1	1	1	0.8400	±0.5%
0	1	1	1	1	1	1	1	0.8125	±0.5%
1	1	1	1	1	1	1	1	Shutdown	

Pin Diagram of NCP5386B Controller

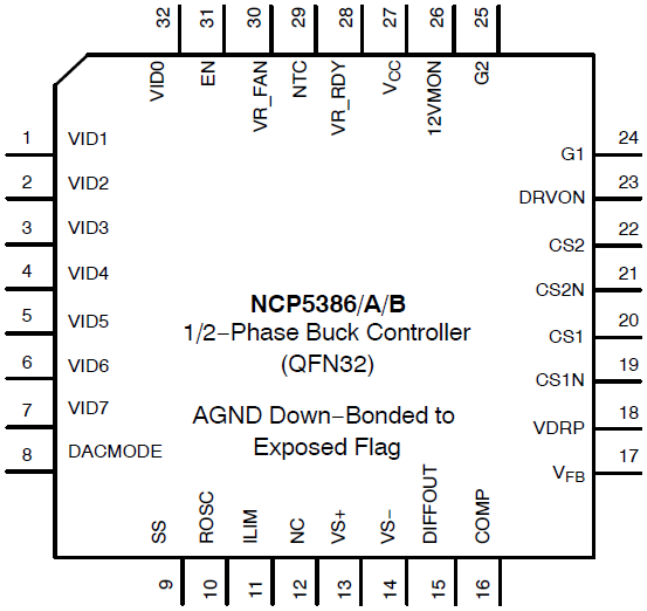

Figure 8. Top View of the Pin Diagram of NCP5386B

Switching Frequency of the Oscillator

The switching frequency of the oscillator can only be changed by changing the resistors R13 and R14.

For more information on NCP5386B: see Data Sheet of NCP5386B.

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